Warm ups:

Earth mass=1.0 Me – radius=0.999 Re
Mars mass=0.107 Me – radius=0.52 Re
Mercury mass=0.0553Me – radius=0.422 Re

Earth
FeMg=0.5 radius = 1.028
=1.0   radius 0.993
=0.3 radius 1.045
=0.01 radius 1.077

Just changing the amount of iron in core/mantle not amount in planet overall
mol_frac_Fe_mantle = 0.01 radius = 1.0
=0.1 radius = 1.001
=0.2 radius =1.004
=0.3 radius = 1.005
=0.4 broken

wt_frac_Si_core= 0.01 same as earth
0.1 — Mass = 1.000 Earth masses
Radius = 1.006 Earth radii
Core Mass Fraction = 25.44
Core Radius Fraction = 50.18
CMB Pressure = 148.17 GPa
number of oceans: 0.00
0.2 fail
0.12 – Mass = 1.000 Earth masses
Radius = 1.003 Earth radii
Core Mass Fraction = 24.33
Core Radius Fraction = 49.89
CMB Pressure = 150.28 GPa
number of oceans: 0.00
0.14 fail
wt_frac_O_core=0.01
Mass = 1.000 Earth masses
Radius = 1.001 Earth radii
Core Mass Fraction = 33.17
Core Radius Fraction = 53.61
CMB Pressure = 138.42 GPa
number of oceans: 0.00
0.1
Mass = 1.000 Earth masses
Radius = 1.016 Earth radii
Core Mass Fraction = 35.31
Core Radius Fraction = 58.60
CMB Pressure = 113.79 GPa
number of oceans: 0.00
0.2
Mass = 1.000 Earth masses
Radius = 1.034 Earth radii

Core Mass Fraction = 38.03
Core Radius Fraction = 63.73
CMB Pressure = 92.27 GPa
number of oceans: 0.00

0.3
Mass = 1.000 Earth masses
Radius = 1.054 Earth radii
Core Mass Fraction = 41.22
Core Radius Fraction = 68.54
CMB Pressure = 74.53 GPa
number of oceans: 0.00

0.4
Mass = 1.000 Earth masses
Radius = 1.078 Earth radii
Core Mass Fraction = 44.99
Core Radius Fraction = 73.13
CMB Pressure = 59.45 GPa
number of oceans: 0.00

0.5
Mass = 1.000 Earth masses
Radius = 1.106 Earth radii
Core Mass Fraction = 49.52
Core Radius Fraction = 77.55
CMB Pressure = 46.37 GPa
number of oceans: 0.00
0.6
Mass = 1.000 Earth masses
Radius = 1.139 Earth radii
Core Mass Fraction = 55.07
Core Radius Fraction = 81.84
CMB Pressure = 34.85 GPa
number of oceans: 0.00
0.8
Mass = 1.000 Earth masses
Radius = 1.222 Earth radii
Core Mass Fraction = 71.01
Core Radius Fraction = 90.42
CMB Pressure = 15.73 GPa
number of oceans: 0.00

wt_frac_S_core
0.01
Mass = 1.000 Earth masses
Radius = 0.999 Earth radii
Core Mass Fraction = 33.17
Core Radius Fraction = 53.30
CMB Pressure = 140.42 GPa
number of oceans: 0.00

0.1
Mass = 1.000 Earth masses

Radius = 1.000 Earth radii
Core Mass Fraction = 35.31
Core Radius Fraction = 55.85
CMB Pressure = 130.13 GPa
number of oceans: 0.00

0.3
Mass = 1.000 Earth masses
Radius = 1.002 Earth radii
Core Mass Fraction = 41.22
Core Radius Fraction = 62.04
CMB Pressure = 107.11 GPa
number of oceans: 0.00

0.5
Mass = 1.000 Earth masses
Radius = 1.004 Earth radii
Core Mass Fraction = 49.52
Core Radius Fraction = 69.27
CMB Pressure = 82.71 GPa
number of oceans: 0.00

0.9
Mass = 1.000 Earth masses
Radius = 1.016 Earth radii
Core Mass Fraction = 83.04
Core Radius Fraction = 90.47
CMB Pressure = 20.68 GPa
number of oceans: 0.00

5.
Orthopyroxene (column N in output file)
Adjust si/mg
Just earth (0.9) : depth 328-0, abundance around 40-60 in this region
SiMg=0.5, no orthopyroxene
SiMg=0.7, 0.3-14.8 abundance, depth 322-surface

Useful parameters: wt_frac_O_core, FeMg, mass (all these affected radius), SiMg affected abundances

Getting Started:

System : Trappist 1
https://exoplanetarchive.ipac.caltech.edu/overview/trappist%201#system_parameters

Trappist one stellar properties : 0.040 + 0.080 [Fe/H] (Gillon et. al 2017)

Use Griffith paper to find [Mg/H] and [Si/H] then convert to molar ratios Si/Mg Fe/Mg

(Griffith et al. 2020)
Use fig. 3 : [Fe/H]=0.040, upper left panel gives [Mg/Fe],

(or alternatively, Fig. 1 panel 2),
I assumed the star, Trappist one is in a region that is directly in the middle of the high and low 1a regions (along the dashed line in Fig 1).

[Mg/fe]=0.12 (approx)

Solve for Fe/Mg

Use Equation from slides 4 to convert

(SEE MATH DOCUMENT)

Fe/Mg ~0.68
Si/Mg ~0.94

Choose planet (trappist 1 e)

Expected values: https://exoplanets.nasa.gov/exoplanet-catalog/3453/trappist-1-e/

1. Fe/Mg = 0.68
   Si/Mg = 0.94

2. Use input variables in ExoPlex : FeMg=0.68 SiMg=0.94 mass=0.772

(mass is 0.772 +0.079 /- 0.075 from Grimm et al. 2018)

ExoPlex Output in data file : Trappist 1 e change FeMg SiMg mass

Mass = 0.772 Earth masses
Radius = 0.943 Earth radii
Core Mass Fraction = 26.65
Core Radius Fraction = 49.03
CMB Pressure = 117.90 GPa
number of oceans: 0.00

(Expected Radius is 0.910
+0.026
-0.027 from Grimm et al. 2018)

From ExoPlex: Density at core is around 12.9 g/cm^3 and at surface is about 3.07 g/cm^3
NEA data Grimm et al. 2018 suggests 5.646
+0.419
-0.386

Value calculated (assuming Uniform density)

Density= 5.06 g/cm^3 (see hand calculation PDF)

4. Ideas: We need to decrease radius,

Decreasing FeO will decrease radius
FeMg (core mass fraction) increasing this decreases radius

Core comp
Si : increase to decrease radius
O: increase to increase radius
S: increase to increase radius

Our current radius: 0.943 , we want 0.91

First try: increase FeMg=0.7 Radius= 0.941

python Group_1.py --SiMg=0.94 --FeMg=0.8 --mass=0.772
Radius: 0.935

python Group_1.py --mass=0.772 --SiMg=0.94 --FeMg=0.7 --mol_frac_Fe_mantle=0.007 --wt_frac_Si_core=0.02 --wt_frac_S_core=0.007

python Group_1.py --mass=0.772 --SiMg=0.68 --FeMg=0.75

Using these values we get 0.932 Re, this is still off from the expected value, but we determined that the only thing that will dramatically lower our radius to the 0.91 that we need is increasing the Fe/Mg ratio, and we think that it is unrealistic for Trappist 1e to have a higher Fe/Mg ratio than what we have listed. Other papers were getting values close to 0.92. We made a lot of assumptions with our calculations for the molar ratios, so our error likely comes from there.

Mantle Mineralogy: Plots on Excel

Assumptions Outlined:

In our own calculation of density we assumed evenly distributed mass (which is inaccurate, but got us a ball park estimate, this value was not used in later estimates, so it was fine). We used the mass from a paper (listed),

We used the [Fe/H] value listed on NEA for Trappist 1. From there I used the second panel on Fig. 1 in Griffith et al. 2020 (I sent this picture in group me), and approximated what the [Mg/Fe] value would be. This was a huge assumption because it involved eyeballing the figure for the [Fe/H], eyeballing the associated value for [mg/fe] and in that we also assumed that trappist 1 would be located in an intermediate region of sorts, and not in either high or low ia regions. From there, I used [Mg/Fe] to find [Fe/Mg] which allows us to use table 2 to find the [Mg/H] value. Here we made another assumption. My calculated value of [Fg/Me] was -0.12, but the closest value listed in the table was -0.134. We agreed to adopt that value since our Fe/Mg was based entirely on visual estimates of the plot and we were willing to accept this error to be able to finish. From there I used table 1 to find the corresponding [Si/Mg]. Having all of these values, i converted Fe/Mg and Si/Mg to molar ratios. And we plugged those in to exoplex. From there we adjusted values to try to get our radius as close to the radii listed on NEA as possible.